ORIGINAL

Before the
Federal Communications Commission
Washington, D.C.

In the Matter of	)	
	)	
Revision of Part 15 of the Commission's Rules	)	ET Docket 98-153
Regarding Ultra-Wideband Transmission Systems	)	
	)	

Initial Comments of the
United States Department of Transportation

Introduction

The Federal Communications Commission ("FCC" or "Commission") began this proceeding with a Notice of Inquiry ("NOI") to gain information about a technology that differs substantially from traditional devices that emit narrowband radiation. ET Docket No. 98-153, 63 Fed. Reg. 50184 (September 21, 1998). It is this technology's core difference – the emission of ultra-wideband ("UWB") radiation – that offers the potential for public and private benefits. It is this same difference that carries with it the risk of interference with existing uses of the radio frequency spectrum. Some of those uses are of fundamental interest to the United States government. These include critical communications, navigation, and surveillance ("CNS") systems. The usefulness of these systems has transformed them into fundamental elements of the nation's infrastructure, providing essential safety and operational support to much of the transportation industry and to many other segments of the economy and society generally. Many potential major improvements to the country's transportation system are critically dependent upon the technological evolution of these CNS systems.

The National Telecommunications and Information Administration ("NTIA"), an agency within the U.S. Department of Commerce that manages the

federal government's use of the spectrum, will represent this interest generally in this proceeding. The U.S. Department of Transportation ("DOT" or "Department") is the federal agency responsible for safe and efficient transportation nationwide. We fully support the views of the NTIA expressed in this proceeding. DOT will supplement NTIA's comments by emphasizing the necessity for continued interference-free use of those restricted bands of the spectrum upon which all modes of transportation rely for safe operations. We will focus in particular on the critical role played by the Global Positioning System ("GPS").

At the outset, the Department shares what we understand to be the Commission's fundamental premises in this proceeding. First, that UWB is a promising technology that may offer significant public and private benefits. Second, that existing technologies and their users, particularly those involved with safety-of-life functions like GPS, must continue to be protected from interference. Third, that carefully structured testing programs should determine the appropriate nature and extent of that protection insofar as UWB emissions are concerned. As the FCC recognized, a corollary of these premises is that, until test data are digested, translated into protective technical criteria, and then into regulatory provisions, the risk of interference precludes unfettered use of UWB technology. The unique nature of UWB technology and the variety of possible applications point up the difficulty of this task.

DOT will discuss these principles below. We begin by outlining the role of the Department and the importance of the spectrum upon which it and transportation providers and users of every variety rely.

Public Safety and the U.S. Department of Transportation

Radionavigation systems are thoroughly dependent upon spectrum. They are also crucial to the federal government and to the nation at large. The Department is the largest governmental user of spectrum outside of the Department of Defense ("DOD").

Indeed, together with DOD we prepare the biennial Federal Radionavigation Plan ("FRP"), which is the official source of information regarding policies and plans for federally provided radionavigation systems. GPS is one of these systems. Although DOD is responsible overall for operating GPS, DOT has been designated as the lead civil agency and, with DOD, jointly chairs the Interagency GPS Executive Board. U.S. Global Positioning System Policy, Presidential Decision Directive, March 29, 1996.

Satellite-based GPS signals are used for positioning, timing, and measurement purposes. The basic GPS signal does not provide the level of accuracy, reliability, and integrity necessary for the safety missions of DOT and others, however. The original GPS system has therefore been augmented to meet the more stringent standards required for safe navigation. For example, the Federal Aviation Administration ("FAA"), a component of the Department, is augmenting GPS to allow its use in the full range of aviation operations, including precision approach and landing operations with its Wide Area Augmentation System ("WAAS") and Local Area Augmentation System ("LAAS") programs. The U.S. Coast Guard, another part of DOT, has developed a Radiobeacon Differential GPS ("DGPS") augmentation system to achieve the accuracy required for missions such as ensuring safe ship passage in rivers and in harbors. The success of such augmented GPS systems has attracted a user community far beyond their original aviation or maritime constituencies. Today, a great many systems and users, public and private, depend upon GPS or augmented GPS systems. *See* Attachment 1. Not surprisingly, the FRP essentially designates GPS as the federal government's primary civilian radionavigation system for the foreseeable future.

GPS and augmented GPS systems now play a central role in maintaining a safe and efficient transportation system in this country. That role is steadily expanding. Because of this fact, and because the low received power of the GPS signal renders it vulnerable to interference, it requires special consideration in this proceeding.[1] NPRM at ¶¶ 28-30.

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[1]/ Protection of the basic GPS signal is required for the operation of the augmented GPS systems.

DOT is comprised of various operating administrations, each of which is charged with specific aspects of the agency's basic mission of safe and efficient transport. All modes of transportation -- air, sea, and land -- are encompassed. A very brief summary of the Department's key operating administrations affected by this proceeding follows.

A. Air Transportation

The FAA is the primary federal agency responsible for safe, secure, and efficient air transportation. In addition to the certification of aircraft and pilots and many other safety functions, the FAA operates and maintains communications, navigation, and surveillance systems for the protection of the flying public. Their role is such that most of these systems operate in the protection of restricted frequency bands. *See* 47 C.F.R. Part 87. These bands have been allocated for GPS and other aviation systems worldwide. Participating nations at the recent World Radiocommunication Conference 2000, including the U.S. and all of its major partners, reaffirmed their commitment to protecting the GPS signal. A great many critical aviation systems operate within the spectrum in which UWB devices have been proposed. In addition to GPS, which is the cornerstone of the evolving National Airspace System infrastructure, these include VHF and UHF air-ground communications, instrument landing systems, en-route and terminal radars, microwave landing systems, and traffic collision avoidance systems. Moreover, the systems used by FAA comply with international standards set by agreements and treaties, so that air travel systems are essentially seamless around the globe. [2]

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[2]/ The International Civil Aviation Organization has promulgated standards for WAAS, and is expected to do likewise as LAAS is further developed.

B. Water Transportation

The U.S. Coast Guard has four main missions: maritime safety, maritime law enforcement, marine environmental protection, and national security. These require the Coast Guard to deploy and maintain navigation aids, patrol U.S. coastal areas and international waters, issue standards for vessel construction (including oil tankers), and operate a large fleet of vessels and aircraft.

The Coast Guard depends upon wireless telecommunications systems which also conform to international standards. They are interoperable with vessels and systems throughout the world, for search and rescue telecommunications, for broadcasting urgent marine safety warnings to vessels, and for command and control communications with its vessels, aircraft, and other federal and local public safety agencies. One example is the Search and Rescue Satellite-Aided Tracking system, in which the National Oceanic and Atmospheric Administration ("NOAA") operates local terminals to detect and locate distress alerts from emergency locator beacons.

Some of these systems are characterized by high power levels. For example, the Coast Guard operates a National Distress System of over 300 VHF antenna towers covering coastal and inland waters of the U. S., including most metropolitan areas.[3] Others, like augmented DGPS, employ low power signals. The Coast Guard operates over sixty-five DGPS sites now, and anticipates that by 2003 some fifty additional sites will provide extremely precise data for location, timing, and measurement purposes nationwide. This advances safety by allowing, *inter alia*, more accurate placement of navigation aids (within two meters), the use of automatic identification systems by ships and harbor control authorities, operations in adverse weather or restricted spaces (vessel location within one to three meters), and more rapid response to mariners in

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[3]/ The Coast Guard receives over 20,000 distress calls from recreational and commercial vessels each year over this system. It also operates eight high seas communications stations, as well as numerous aeronautical radiocommunications and maritime radionavigation stations.

distress. [4] These systems must and do operate reliably, at an availability rate approaching 99.9 per cent. Finally, the Coast Guard relies as well on commercial wireless cellular and mobile satellite systems to perform its duties.

C. Surface Transportation

Travel on land is the most familiar, most extensive mode of movement. It embraces every conceivable iteration of motor vehicles as well as the nation's railroads. DOT operating administrations participate in every venue.

The Federal Highway Administration ("FHWA") promotes safe and efficient transportation in many ways: through support for the construction and maintenance of the nation's interstate highway system, the promulgation of engineering standards, and sponsorship of programs among state and local agencies that involve accident detection and management, emergency response, and the provision of safety-related information to the traveling public. [5]

The Commission is already aware of the role of FHWA as the lead federal agency for the development of technologies collectively known as the Intelligent Transportation System ("ITS"). *See, e.g.*, ET Docket No. 98-95, 64 Fed. Reg. 66405 (November 26, 1999) (allocation of spectrum for Dedicated Short Range Communications). With state and local governments, FHWA promotes research in and the application of ITS technologies that aid in assessing and reporting traffic, road, and weather conditions; emergency responses to natural disasters and accidents involving all modes of transportation; and enhancing the security of the traveling public. The ITS program embraces GPS technology. GPS-based navigation systems are already installed in millions of public and private vehicles; many of these assist in prompt

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[4]/ Ships have become increasingly dependent upon GPS for navigation in both restricted and open waterways. Depending upon the results of testing, discussed *infra*, the restricted space aboard ships may preclude operation of UWB transmitters within the confines of vessels or in close proximity to them.

[5]/ Until recently, FHWA was also responsible for regulating motor carrier safety. That task has now fallen to the Federal Motor Carrier Safety Administration, another operating administration of the Department.

identification and location in emergency situations. FHWA is also studying the use of other innovations such as GPS-guided snowplows, which could function in conditions that would preclude other operations. This application would require a system accuracy of twenty centimeters on an uninterrupted basis.

The Federal Transit Administration ("FTA") is vitally important to the planning, funding, and operations of much of the nation's almost 6,000 public transportation systems. In communities large and small, buses, light/commuter rail, subways, and vehicles dedicated to assisting the disabled bring millions of citizens to work, to recreation, to medical care, and elsewhere because of the FTA. Public transit providers do so safely and efficiently in part because of wireless communications among moving vehicles and base units that go far beyond traditional dispatching functions: to monitor vehicle security, to provide for responses (by transit and/or local police and other public safety agencies) to incidents of all kinds, to transmit operational data automatically, and to activate traffic signal preemption and priority systems. Public transit agencies use GPS to locate and schedule some 60,000 vehicles nationwide, and to keep their passengers informed and safe.

The Federal Railroad Administration ("FRA") regulates the safety of the country's railroads and conducts research in support of improved rail transportation. The railroad industry employs spectrum via a sophisticated radio network to control train movements: for dispatching, safety monitoring, remote defect detection, and a variety of other safety-related purposes. This network (the Railroad Radio Service) is coordinated via the Association of American Railroads to ensure constant access to clear channels. It is, and must be, interoperable nationwide, for track and equipment are shared among multiple freight railroads and Amtrak, as well as commuter and light rail systems.

Railroads use DGPS to track the movement of trains and individual cars, and thereby help in the avoidance of accidents. They also rely upon DGPS to locate track and equipment defects. FRA itself is exploring the use of DGPS

signals in its Positive Train Control ("PTC") initiative. Through PTC trains would be controlled via an integrated system of communications, rather than traditional track signal-based methods. Such a system has been on the National Transportation Safety Board's "Most Wanted Transportation Improvements" list for ten years. Finally, FRA has embarked upon a project that is analogous to the ITS program. It is known as Intelligent Railroad Systems ("IRS") that, in sum, will study the use of digital wireless communications to make train operations more safe and efficient. [6]

Thus, whether directly as a user or indirectly as a facilitator or overseer of safe and efficient transportation, the Department is keenly interested in the continued interference-free use of spectrum to assure public safety and security throughout the nation's transportation network. Sound public policy also dictates that the scope of the Commission's inquiry expand, like the use of GPS, beyond the transportation sphere.

The most important purpose of all these systems is to protect and preserve lives. But it also warrants emphasis that the very spectrum that advances the public safety -- *e.g.*, air traffic control communications or traffic management systems -- serves other public and private interests as well, -- *e.g.*, efficiency and economic growth. The more efficiently these systems operate, the more widespread they become and the more they advance safety. Similarly, the very real financial investment that these systems represent is another factor worthy of the Commission's consideration. Billions of dollars of public and private funds have been spent, and future applications indicate that more will follow. This has not been and should not be jeopardized by interference from other sources.

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[6]/ IRS encompasses information displays in locomotives, automatic identification equipment, electronically controlled brakes, track and rolling stock defect sensors, intelligent grade crossings, and other potential uses.

Finally, the United States' adherence to internationally agreed-upon standards governing the use of spectrum in various transportation-related particulars must also be taken into account.

Ultra-wideband Technology and Public Safety

The Department, like the FCC, considers UWB a promising technology. It has the potential to improve transportation safety as well as to serve other laudable purposes. For example, FHWA's role in the construction and maintenance of the nation's highway network has led it to consider various UWB applications. Ground-penetrating radar, for example, could be quite useful in the non-destructive testing of roadway composites and bridge decks. UWB devices may also be a means of communicating between vehicles and in collision avoidance. Future developments may include monitoring of various vehicle or engine parameters that relate to safety, like road surface friction.

There may also be UWB applications of value in the public transit context. This technology could offer an alternative means of communication between transit vehicles and dispatchers or maintenance facilities. It could also help determine vehicle occupancy in High-Occupancy-Vehicle lanes.

FRA and the railroad industry might have recourse to UWB's ground-penetrating capabilities too; for example, to ascertain the solidity of track embankment after, say, flooding or an avalanche.

Testing to Determine UWB Operating Conditions

The foregoing should serve to underscore what the Commission repeatedly acknowledged in its NPRM: that UWB technology may introduce new and valuable devices, but that any such devices must not cause interference to existing uses, especially those in restricted frequency bands. NPRM at ¶¶ 1-12, 24, 27, 28, 39. The Department accordingly and whole-heartedly endorses the FCC's expressed intention to gather testing data so as to understand the risks of

interference before permitting UWB operations, and only then pursuant to rules that would avoid those risks. Id. at ¶¶ 1, 6-8, 27, 30, 32.[7] Until answers are available, the Commission is prudent to follow "a conservative approach." Id. at ¶ 21. We appreciate in particular the Commission's solicitude for "critical safety systems ... including GPS operations" and its concern for the "serious detrimental impact on public safety, businesses, and consumers" attendant upon interference with GPS. Id. at ¶¶ 24 and 28, respectively.

Because information submitted in response to the NOI indicated a potential for interference to other spectrum users from UWB, the federal government decided to sponsor testing programs to explore this potential in greater detail. NTIA and DOT developed test plans in coordination with each other.

NTIA is conducting a wide range of tests. It originally sought both to accurately characterize UWB signals and to determine the potential for interference from UWB on a variety of aviation CNS systems other than GPS. To determine the interference mechanism for aeronautical systems requires consideration of more than just receiver sensitivity. Testing must take into account, for example, the probability of detecting a target for a radar or needle deflection that occurs in an instrument landing system in the presence of broadband interference (*e.g.*, FM broadcasts). Protection margins must be maintained to ensure that the probability of loss of system integrity is not reduced below 0.9999999. There are similar extremely high standards for system continuity and availability. The FAA is working with NTIA to assist that

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[7]/ Any interim uses should, of course, reflect the Commission's coordination with NTIA of the conditions under which waiver requests might be considered. Id. at ¶ 6. The Commission should be particularly chary of UWB devices with mass market potential until more is known. Even low power devices could result in widespread harm if their emissions were later found to be incompatible with other systems. *Cf.* NPRM at ¶ 18.

agency's analyses of the susceptibility to UWB interference of various government systems.

Due to funding constraints, the time frame of this proceeding, and the primacy of GPS-based systems, DOT has concentrated on studying the potential for interference from UWB emissions on the GPS signal. [8] *See* NPRM at ¶ 31. DOT's test plan was also widely disseminated for peer and public review. [9] A copy is attached for the Commission's convenience. Attachment 2. The purpose of these tests is to determine whether and under what conditions there is interference between UWB and GPS reception, and following from that, whether and to what extent technical and operational restrictions on UWB design and use are necessary to avoid interference to GPS-based systems. The NTIA and DOT test plans were designed to provide an integrated, comprehensive approach to assessing potential UWB interference. [10]

Although both UWB and GPS signals are of low power compared to most radio frequency systems, the UWB signal is stronger than GPS. Moreover, because UWB is not just one but a family of new technologies with widely varying implementations and applications, the number of parameters to test is potentially quite large. Attempting to determine which are the most important for characterizing the UWB technologies and their impact on other systems is one of the goals of the test plans. Further, DOT's test plan does not address conditions that might be anticipated with UWB-based communications systems.

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[8]/ Stanford University is conducting the tests on behalf of DOT.

[9]/ Opportunities for comment on the test plan were specifically provided to NTIA and all federal agencies represented on the Interdepartment Radio Advisory Committee ("IRAC"), the FCC, the RTCA and others. The public was offered an opportunity to comment through a Federal Register notice. 65 Fed. Reg. 38874 (June 22, 2000).

[10]/ We understand that recent additional funding has enabled NTIA to expand its testing regime to include GPS, building on the original DOT and NTIA plans. This should provide even more valuable information for the record.

See NPRM at ¶ 12. The interference potential of this kind of application, which could involve higher power levels and synchronized emissions, also must be studied.

DOT's testing is under way but incomplete at this time. Very preliminary results may be summarized as follows: UWB emissions can interfere with GPS receivers or may be benign, depending upon the UWB parameter(s) varied and/or the operational scenarios considered. Parameters that thus far appear to have an impact on the existence and extent of interference with GPS include the pulse repetition frequency ("PRF"), burst on-time, and modulation. Lower PRFs, lower duty cycles, and dithering the UWB signal appear to help minimize the potential for UWB interference with GPS. All of these need to be better understood prior to regulatory action.

Some of DOT's very preliminary results are also counter-intuitive, which indicates that further testing is necessary. For example, testing has shown that a UWB signal with a PRF of 20 MHz will cause the GPS aviation receiver to exceed the defined pseudorange accuracy threshold at power levels around -89 dBm, but the GPS receiver did not lose lock on the GPS signal. By contrast, with a (substantially similar) PRF of 19.94 MHz, the GPS receiver lost lock on the signal at a power level far below the defined threshold value. This relationship needs further research to determine the appropriate cause and effect, and the potential impacts on GPS-based systems. Finally, very preliminary test results show that UWB emissions can create spectral lines that can have detrimental effects if they fall on or near the GPS L1 signal band.

We must emphasize that DOT's initial testing assesses only the interplay of one GPS receiver and one UWB emitter. The above very preliminary results therefore point out the importance of testing other combinations of emitters and receivers. Moreover, because there are potential mass market uses for some UWB devices (NPRM at ¶¶ 11, 18), even in those cases where a particular UWB device appears to be benign, there still is the potential for interference from

multiple UWB emitters of the same type. Only additional testing of this aggregate effect will provide the necessary data to determine whether this is the case. The further testing being undertaken by NTIA in this area should be very useful in this regard.

Further, there are other emitters authorized by the FCC and present in the total electromagnetic compatibility environment of the GPS signal. These systems and their potential proximity with UWB devices must also be analyzed. The testing that is under way at Stanford and NTIA will address at least some of these issues.

At this point it is unfortunately easier to state what is unknown about the effects of UWB emissions on GPS and other protected signals than what is known. The Department can only stress its agreement with the Commission's assertion that before it is possible to determine the appropriate regulatory treatment for UWB where restricted frequency bands are concerned, it is necessary to understand thoroughly the technical characteristics and behavior of its signals. NPRM at ¶¶ 1, 4, 24, 28. This is vital, even if the necessary test results are not available as quickly as one would like. [11] The FCC has taken the correct course, in DOT's view, by promising an ample opportunity to complete needed testing and for public comment thereon before adopting final rules. Id. at ¶¶ 1, 7.

Regulatory Proposals and Approaches

The Commission has observed that most UWB devices cannot avoid transmitting into restricted frequency bands and cannot operate under current regulations. NPRM at ¶¶ 7, 23. The technology's potential, however, has led the FCC to attempt to foster its development and to amend applicable regulations. Id. at ¶¶8, 23. The result to date has been a set of preliminary proposals to (1)

[11]/ DOT will submit available test results and analysis by October 31, 2000, in accordance with the schedule established by the FCC. However, we anticipate that our testing program, and that of NTIA, will not be completed until sometime later.

permit low-power, mass market UWB devices to operate on an unlicensed basis, (2) allow ground-penetrating UWB devices to operate in frequencies below 2 GHz subject to certain restrictions, and (3) place no restrictions on UWB devices operating in frequencies above 2 GHz. Id. at ¶¶ 18, 25, 27.

The Department understands better than most the promise of emerging technology. Every breakthrough, however, whether in telecommunications, transportation, or other fields, has of necessity demanded rigorous testing before exposure to the public. UWB is no exception.

Because the record establishes nothing so much as the need for caution where safety-of-life and sensitive CNS systems are concerned, DOT urges the Commission not to finalize the above proposals until all necessary testing and analysis are complete. As previously noted, it is premature to allow the use of mass market devices (even low power ones) before test results are analyzed, for it is virtually impossible to eliminate the risk of interference once a product is widely disseminated. Note 7, *supra*. Furthermore, the Department is unaware of any basis to grant unqualified approval to UWB devices operating above 2 GHz. Sensitive CNS systems function in protected frequency bands above that level, including aeronautical systems such as en-route and terminal radars, airborne radars, and the internationally standardized microwave landing system. Although shifting UWB operations to higher frequencies may hold some promise, DOT's main point is that the impact of UWB emissions must always be clearly understood, and the risk of interference addressed, before such decisions are made.

Caution in the face of new technology is appropriate; condemning it out of hand is not. Thus, test data may ultimately show the second proposal, properly structured, to have merit. The circumstances of use of ground-penetrating radar (energy directed into the ground, low proliferation, etc.) and the restrictions mentioned by the Commission (shielding, failsafe devices) may adequately guard against interference, but additional protections may also prove necessary

for existing services and safety systems. Like the Commission, we are less confident of the proper treatment of UWB devices used to penetrate walls and other solid surfaces. NPRM at ¶ 26. We will review the initial comments of other parties on this subject with interest.

The Department wishes to suggest as well that the FCC consider different regulatory options. The qualitatively different nature of UWB technology – in the "breadth" of its emissions and in the pulse-base of its energy rather than wave-base – and the potential noted by the Commission for many variations may make it preferable to adopt a new approach. The notion that a frequency "dividing line" may be profitably employed deserves further study, even if the 2 GHz demarcation proposed in the NPRM may not be appropriate in light of final test results, in DOT's opinion. Id. at ¶ 27. Alternatively, a different subpart to Part 15 or even an entirely new part of the FCC's rules could perhaps best address the issues and opportunities posed by UWB technology. As test data becomes available, it may support a "modular" approach by the FCC in which, for example, licenses would be necessary for some but not all uses. Ground-penetrating radar may be a good candidate for earlier regulatory action, assuming the proper conditions are in place. The Commission should be prepared to be as flexible as test results allow: once existing protected uses and frequency bands are secured, as many potential benefits of this new technology as possible should be realized.

Conclusion

The Department shares what we understand to be the core principles underlying this proceeding. UWB is a promising and singular technology worthy of further exploration. Like any other technology, however, it must not interfere with vital safety-of-life communication, navigation, and surveillance systems that have become critical in the transportation sector and others. Sound public policy therefore supports the Commission's commitment to obtain and

analyze test results in order to determine whether and to what extent restrictions on UWB emissions are necessary to protect these systems and thereby continue to safeguard the public. DOT looks forward to contributing to the technical record that will form the basis for the FCC's regulatory action.

Respectfully submitted,

Rosalind A. Knapp
Acting General Counsel

September 12, 2000